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☐ 1. Document ID: US 6738821 B1

L3: Entry 1 of 6 File: USPT May 18, 2004

DOCUMENT-IDENTIFIER: US 6738821 B1
TITLE: Ethernet storage protocol networks

Brief Summary Text (20):
In yet a further embodiment, a storage area network (SAN) is disclosed. The SAN includes a server system including one or more host computer systems. Each host computer system includes network interface circuitry and host peripheral interface circuitry. The network interface circuitry is configured to communicate data using a TCP protocol and the host peripheral interface circuitry is configured to communicate data using an Ethernet storage protocol (ESP). A storage box is also provided having one or more storage drives, and the storage box has a bridge circuit for communicating data using the ESP. The network also includes an Ethernet switch for communicating the server system to the storage box. The ESP is configured to: (i) select portions of the data; (ii) attach storage encapsulation protocol (SEP) headers to the selected portions of the data; (iii) attach simple transport protocol (STP) headers to one or more of the selected portions having the SEP headers to produce STP packets; and (iv) encapsulate the STP packets into Ethernet frames for communication over the network including the Ethernet switch. In this network environment, one or more desk top computers may be connected to the network interface circuitry of the server system. The desk top computers have standard network interface cards (NICs) for communicating standard Ethernet frames to and from the server system. The ESP is configured to add an IP header after the STP header of the STP packets for communication over one of a level 3 router and a level 3 switch. In this embodiment, each of the one or more host computer systems can be servers that are not necessarily homogeneous (i.e., each can operate using different operating systems like Windows.TM. NT, Windows.TM. 2000, UNIX, Linux, Sun Microsystems Inc. Solaris, etc.). Further, each host computer system can be a cluster if desired. Of course, the cluster will include two or more homogeneous computer systems (i.e., running the same operating system).

Brief Summary Text (21):
The advantages of the present invention are many and substantial. Most notably, the Ethernet storage protocol (ESP) of the present invention simplifies the communication elements needed to transfer data over a network and enables nearly unlimited scaleablity. The ESP preferably implements a simple transport protocol (STP) that requires less CPU processing than conventional TCP. It is estimated that CPU utilization for networks using ESP may be as small as 1/5 of networks using TCP. In a more preferred embodiment, the ESP will be implemented primarily using hardware and simple software drivers in order to further limit CPU requirements. The ESP also preferably takes advantage of a storage encapsulation protocol (SEP) which is configured to encapsulate portions of storage data, such as SCSI data, ATAPI data, UDMA data, etc. In communication, senders and targets establish communication sessions by exchanging handles, which are used to identify the

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senders and targets in subsequent communication transactions. Once a session is open, the session preferably will remain open for the entire time the target and host are connected to the ESP network. Another advantage of the present invention is that Ethernet frames are counted to determine whether packets have successfully been transferred. This is substantially more efficient than prior art techniques utilizing TCP, which rely on byte counting and complicated time-out calculations.

Drawing Description Text (1):
Finally, it will become apparent to those skilled in the art that the ESP of the present invention can have applicability in desk top and server applications, cluster server systems, storage area networks, and other storage networking applications. Other aspects and advantages of the invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

Drawing Description Text (19):
FIG. 4C illustrates an encapsulation technique for parallel SCSI phases for use on serial protocols, in accordance with one embodiment of the present invention.

Detailed Description Text (4):
In one embodiment, the transported data will be in the form of SCSI data, which is encapsulated for communication using a storage encapsulation protocol (SEP). In another embodiment, the transported data can be ATAPI data, UDMA data, or any other data that can benefit from the efficient network communication of the ESP of the present invention.

Detailed Description Text (21):
In either case, the cluster server system 130 will gain access to multiple storage area networks (SANs), which are preferably connected by way of a switch. In this illustration, a switch 126, which is preferably a standard level 2 Ethernet switch, is provided to connect the cluster server system 130 to storage boxes 132. As mentioned above, the storage boxes 132 can have multiple drives for storing data. The drives can be hard drives, optical disc drives, tape drives, RAID arrays, and the like. If standard off-the-shelf drives are used (e.g., SCSI hard drives), then a bride circuit 131 can be provided as part of the storage box 132 or can be provided as an external bridge circuit. This example also shows that native ESP targets 106 (e.g., such as hard drives, tape drives, optical drives) can be directly connected to the SAN #1. Thus, a SAN can be made of native target devices and non-native target devices using suitable bridge circuitry to implement the ESP operations.

Detailed Description Text (36):
FIG. 4B defines a table that illustrates the SCSI phase definitions as well as the information transferred definitions used in FIG. 4A. FIG. 4C illustrates an encapsulation technique for parallel SCSI phases for use on serial protocols. An SEP header is added to each segment of information to identify the type of information (i.e., which phase it comes from), that the segment carries. In other embodiments, for commonly occurring information pairs such as command plus write data and read data plus status, a single header can be shared by defining a special paired type. Because tag commands are typically used, requiring a tag message phase with each command, status, or data phase, the tag is combined with the header. By using a separate session for LUN (for those devices which have multiple LUNs), the LUN and SCSI ID information is implicit in the choice of session over which the encapsulated SCSI is sent.

Detailed Description Text (52):
The simple transport protocol (STP) will now be described with reference to exemplary SCSI transactions. STP provides a low overhead, LAN-oriented transport to efficiently and reliably move blocks of data to and from target devices. As described above, the host computers should have a PIC to enable communication in

accordance with the ESP and the target devices should be native ESP devices. Alternatively, the target devices can be off-the-shelf devices that can gain access to the ESP network by way of a bridge circuit 131, as described with reference to FIG. 1C. Also important to note is that STP can either be used alone without IP for some small LAN environments and in other cases STP can be run over IP for larger LAN environments or communications over routers and the Internet. In a preferred embodiment, where SCSI data is being moved, STP will move SCSI data that has been serialized and encapsulated using the described SEP protocol.

CLAIMS:

16. The network of claim 12 being one of a cluster server storage network and a storage area network (SAN).

17. A storage area network (SAN), comprising: a server system including one or more host computer systems, each host computer system including network interface circuitry and host peripheral interface circuitry, the network interface circuitry being configured to communicate data using a TCP protocol and the host peripheral interface circuitry being configured to communicate data using an Ethernet storage protocol (ESP); a storage box including one or more storage drives, the storage box having a bridge circuit for communicating data using the ESP; and an Ethernet switch for communicating the server system to the storage box; wherein the ESP is configured to, (i) select portions of the data; (ii) attach storage encapsulation protocol (SEP) headers to the selected portions of the data; (iii) attach simple transport protocol (STP) headers to one or more of the selected portions having the SEP headers to produce STP packets; and (iv) encapsulate the STP packets into Ethernet frames for communication over the network including the Ethernet switch.

18. A storage area network (SAN) of claim 17, further comprising: a desk top computer being connected to the network interface circuitry of the server system, the desk top computer having a standard network interface card (NIC) for communicating standard Ethernet frames to and from the server system.

19. A storage area network (SAN) of claim 17, wherein the ESP is further configured to add an IP header after the STP header for communication over one of a level 3 router and a level 3 switch.

20. A storage area network (SAN) of claim 17, wherein the STP headers include at least a handle field, a type field, a length field, a sequence number field, and an acknowledgment field.

21. A storage area network (SAN) of claim 20, wherein the handle field is used to exchange a handle during the commencement of a session, the handle being exchanged between a sender and a target of the network.

26. A storage area network (SAN), comprising: a server system including one or more host computer systems, each host computer system including network interface circuitry and host peripheral interface circuitry, the network interface circuitry being configured to communicate data using a TCP protocol and the host peripheral interface circuitry being configured to communicate data using an Ethernet storage protocol (ESP); a storage box including one or more storage drives, the storage box having a bridge circuit for communicating data using the ESP; and an Ethernet switch for communicating the server system to the storage box; wherein the ESP is configured to, (i) select portions of the data; (ii) attach virtual interface protocol (VI) headers to the selected portions of the data; (iii) attach simple transport protocol (STP) headers to one or more of the selected portions having the VI headers to produce STP packets; and (iv) encapsulate the STP packets into Ethernet frames for communication over the network including the Ethernet switch.

27. A storage area network (SAN) of claim 26, further comprising: a desk top

computer being connected to the network interface circuitry of the server system, the desk top computer having a standard network interface card (NIC) for communicating standard Ethernet frames to and from the server system.

28. A storage area network (SAN) of claim 26, wherein the ESP is further configured to add an IP header after the STP header for communication over one of a level 3 router and a level 3 switch.

☐ 2. Document ID: US 6651117 B1

L3: Entry 2 of 6 File: USPT Nov 18, 2003

DOCUMENT-IDENTIFIER: US 6651117 B1
TITLE: Network stack layer interface

Parent Case Text (2):
This application claims priority from: (1) U.S. Provisional Patent Application No. 60/163,266, filed Nov. 3, 1999, entitled "SCSI OVER ETHERNET," (2) U.S. Provisional Patent Application No. 60/189,639, filed Mar. 14, 2000, entitled "ETHERNET STORAGE PROTOCOLS FOR COMPUTER NETWORKS," and (3) U.S. Provisional Patent Application No. 60/201,626, filed May 3, 2000, entitled "SCSI ENCAPSULATION PROTOCOL." Each of these provisional applications is herein incorporated by reference.

Drawing Description Text (1):
Finally, it will become apparent to those skilled in the art that the network stack layer interface of the present invention can have applicability in desk top and server applications, cluster server systems, storage area networks, and other storage networking applications. Other aspects and advantages of the invention will become apparent from the following detailed description, taken in conjunction with the accompanying drawings, illustrating by way of example the principles of the invention.

☐ 3. Document ID: US 6591207 B2

L3: Entry 3 of 6 File: USPT Jul 8, 2003

DOCUMENT-IDENTIFIER: US 6591207 B2
TITLE: Semiconductor production system

Abstract Text (1):
A semiconductor production system has a semiconductor manufacturing apparatus having an exposure unit, a control unit for controlling the exposure unit and a storage device; a semiconductor inspection apparatus having an observation unit, a control unit for controlling the observation unit and a storage device; and a storage device commonly used by the semiconductor manufacturing apparatus and the

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semiconductor inspection apparatus. The manufacturing apparatus, the inspection apparatus and the commonly used storage device are interconnected via a storage area network. With the semiconductor manufacturing apparatus and the storage device linked together via the storage area network, a large volume of image data or design data can be communicated at high speed, thus improving the system throughput.

Brief Summary Text (2):
The present invention relates to a semiconductor production system and more particularly to a semiconductor production system linking a semiconductor manufacturing apparatus, an inspection apparatus and a storage device by using a storage area network.

Brief Summary Text (4):
The storage area network is an independent network which is constructed of only storages, devices for storing data, by separating the storages from a server. Examples of such storage area networks include those networks based on such links as a fiber channel (one of serial interface standards) described in WO 00/18049 and WO 00/17769 and an optical fiber described in WO 00/2954. The storage area network is a general term for networks that link storage devices independently of the kind of communication devices used. A link of storage devices through a serial bus as defined in IEEE1394 and a link of storage devices through a switched bus as defined by InfiniBand (registered trade name) are storage area networks. However, Ethernet which handles storage protocol, such as iSCSI (registered trade name) and SEP (SCSI Encapsulation Protocol), is the storage area networks.

Brief Summary Text (12):
A semiconductor production system comprises: a semiconductor manufacturing apparatus having an exposure unit, a control unit for controlling the exposure unit and a storage device; a semiconductor inspection apparatus having an observation unit, a control unit for controlling the observation unit and a storage device; and a storage device commonly used by the semiconductor manufacturing apparatus and the semiconductor inspection apparatus; wherein the semiconductor manufacturing apparatus, the semiconductor inspection apparatus and the commonly used storage device are linked together via a storage area network. The semiconductor manufacturing apparatus can be used as an apparatus for making masks for fabricating semiconductors.

Brief Summary Text (13):
As described above, with this invention because the semiconductor manufacturing apparatus or storage devices are linked together via the storage area network, a large volume of image data or design data can be transferred at high speed, improving the system throughput.

Drawing Description Text (9):
FIG. 8 is a diagram showing a sequence by which a computer connected to a storage area network generates an inspection position and the semiconductor inspection apparatus executes an inspection.

Drawing Description Text (22):
FIG. 21 is a block diagram showing a semiconductor inspection apparatus with its control unit connected to the storage area network.

Drawing Description Text (23):
FIG. 22 is a block diagram showing a semiconductor inspection apparatus with a plurality of inspection processing apparatus connected to the storage area network.

Drawing Description Text (24):
FIG. 23 is a block diagram showing a semiconductor inspection apparatus when a

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fiber channel is employed as the storage area network.

Drawing Description Text (26):
FIG. 25 is a block diagram showing a semiconductor manufacturing apparatus with its control unit connected to the storage area network.

Drawing Description Text (27):
FIG. 26 is a block diagram showing a semiconductor manufacturing apparatus with a plurality of design information processing apparatus connected to the storage area network.

Drawing Description Text (28):
FIG. 27 is a block diagram showing a plurality of semiconductor manufacturing apparatus connected to the storage area network.

Drawing Description Text (29):
FIG. 28 is a diagram showing a semiconductor manufacturing apparatus when a fiber channel is used as the storage area network and dedicated hardware is mounted in its control unit.

Detailed Description Text (3):
As shown in the figure, a storage area network 40 interconnects a semiconductor inspection apparatus 10, a semiconductor manufacturing apparatus 20 and a storage device 30. The semiconductor inspection apparatus 10 and the semiconductor manufacturing apparatus 20 can also be interconnected via a general network 50. In this embodiment, the provision of the storage area network 40 achieves a large-capacity data communication between the semiconductor inspection apparatus 10 and the semiconductor manufacturing apparatus 20 without affecting the general network 50. Because the storage device 30 is shared by the semiconductor inspection apparatus 10 and the semiconductor manufacturing apparatus 20, data does not have to be copied between the apparatus, thus improving the overall performance of the system and simplifying the data management. It is noted that the manufacturing apparatus 20 can be used not only for making semiconductors but also for making semiconductor masks and that the inspection apparatus 10 can be used not only for inspecting semiconductors but also for inspecting semiconductor masks. For the sake of simplicity, these apparatus will be explained as a semiconductor manufacturing apparatus and as a semiconductor inspection apparatus in the following description.

Detailed Description Text (4):
FIG. 2 is a block diagram illustrating another configuration of the semiconductor production system. As shown in the figure, the storage area network 40 interconnects a semiconductor inspection apparatus 10, a semiconductor manufacturing apparatus 20 and a plurality of storage devices 30. The storage area network 40 employs fiber channels 41 as communication devices and interconnects the fiber channels with a fabric 42. The semiconductor inspection apparatus 10 and the semiconductor manufacturing apparatus 20 are linked together via the general network 50.

Detailed Description Text (5):
In the fabric 42 there are switches and a hub, both of which support a hot plug. This allows additional storage devices 30 to be connected dynamically to the storage area network 40 for extension. Because the fabric 42 allows a cascade connection, a further expansion is possible.

Detailed Description Text (7):
FIG. 3 is a block diagram showing still another configuration of the semiconductor production system. As shown in the figure, the storage area network 40 interconnects a semiconductor inspection apparatus 10, a semiconductor manufacturing apparatus 20 and a plurality of storage devices 30. The storage area

network 40 adopts fiber channels 41 as the communication device connecting the individual apparatus in loop. The semiconductor inspection apparatus 10 and the semiconductor manufacturing apparatus 20 are interconnected through the general network 50. This loop configuration does not require facilities such as fabrics but realizes a simple system that can be built only by connecting fiber optics. This configuration facilitates maintenance and can also achieve a system with duplicated loops easily.

Detailed Description Text (8):
FIG. 4 is a block diagram showing a further configuration of the semiconductor production system. As shown in the figure, the storage area network 40 interconnects a semiconductor inspection apparatus 10, a semiconductor manufacturing apparatus 20 and a plurality of storage devices 30. The storage area network 40 connects them to the communication device in a tree topology according to the IEEE 1394-43. In this configuration, the inspection apparatus 10 or the manufacturing apparatus 20 is taken as a root of the tree. The semiconductor inspection apparatus 10 and the semiconductor manufacturing apparatus 20 are connected together via the general network 50. The IEEE 1394 supports the hot plug, so the storage devices can be dynamically added to the storage area network for expansion.

Detailed Description Text (9):
FIG. 5 is a block diagram showing a further configuration of the semiconductor production system. As shown in the figure, the storage area network 40 interconnects a semiconductor inspection apparatus 10, a semiconductor manufacturing apparatus 20, a plurality of storage devices 30 and a computer 60. The semiconductor inspection apparatus 10, the semiconductor manufacturing apparatus 20 and the computer 60 are linked together via the general network 50. In this embodiment, the provision of the storage area network 40 realizes a large-capacity data communication between the semiconductor inspection apparatus 10, the semiconductor manufacturing apparatus 20 and the computer 60 without affecting the general network 50. The storage device storing data produced in an upstream process such as logic design and the storage device storing data produced in an inspection and manufacturing process have conventionally been separated, so that transfer of information between the two processes is difficult to achieve. With this embodiment, however, there is no need to copy data since the storage devices 30 are shared. This improves the overall performance of the system and simplifies the data management. Further, if a storage area network 40 is selected which can perform a long-distance communication, the installation locations of the semiconductor inspection apparatus 10, the semiconductor manufacturing apparatus 20 and the computer 60 can be set with flexibility.

Detailed Description Text (12):
FIG. 8 illustrates a sequence of operations by which the computer connected to the storage area network generates an inspection position and the semiconductor inspection apparatus executes an inspection accordingly. First, the computer 60 reads design information from the storage device 30 (S200). Then, based on the design information read out, the computer 60 generates an inspection position or inspection area (S210). Next, it writes the generated inspection position into the storage device 30 (S220). The written information serves as a log indicating the execution of the processing. Next, the inspection apparatus 10 retrieves the inspection position from the storage device 30 (S230) and executes an inspection according to the retrieved position (S240). Specifying the inspection position from a device external to the inspection apparatus 10 in this manner can reduce the load of the inspection apparatus and improve its performance.

Detailed Description Text (29):
FIG. 20 to FIG. 23 are block diagrams showing semiconductor inspection apparatus as embodiments of the present invention. FIG. 20 is a block diagram showing an overall configuration. As shown in the figure, the inspection apparatus 10 comprises an

observation unit 12 having an optical image sensing device and others and a control unit 14 for controlling the observation unit. The observation unit 12 and the control unit 14 are connected through the storage area network 40 to a storage device 30 outside the inspection apparatus, a storage device 31 inside the inspection apparatus 10, and an apparatus 60 other than the inspection apparatus. This configuration allows the storage devices to be shared among various apparatus.

Detailed Description Text (30):
FIG. 21 is a block diagram showing a semiconductor inspection apparatus with its control unit connected to the storage area network. As shown in the figure, the inspection apparatus 10 comprises an observation unit 12 having an optical image sensing device and others and a control unit 14 for controlling the observation unit. The control unit 14 is connected through the storage area network 40 to a storage device 30 outside the inspection apparatus, a storage device 31 inside the inspection apparatus, and an apparatus 60 other than the inspection apparatus. This configuration allows the control unit to access all the storage devices inside or outside the apparatus.

Detailed Description Text (31):
FIG. 22 is a block diagram showing a semiconductor inspection apparatus with a plurality of inspection processing appratus connected to the storage area network. As shown in the figure, the inspection apparatus 10 comprises an observation unit 12 having an optical image sensing device and others and a control unit 14 for controlling the observation unit. The observation unit 12 and the control unit 14 are connected through the storage area network 40 to a storage device 30 outside the inspection apparatus, a storage device 31 inside the inspection apparatus, and a plurality of inspection processing apparatus 60. In this configuration, when image data obtained by the inspection apparatus 10 is stored in the external storage device 30, a plurality of inspection processing apparatus 60 can easily access the image data stored in the storage device 30, making it possible to easily realize parallel inspection processing and thereby improve the overall performance of the system. Further, because an inspection processing apparatus 60 can be added to or removed from the storage area network 40 while the system is in operation, the configuration of the inspection processing apparatus 60 can be modified according to variations in the system load.

Detailed Description Text (32):
FIG. 23 is a block diagram showing a semiconductor inspection apparatus when a fiber channel is employed as the storage area network. As shown in the figure, inspection apparatus 10 comprises an observation unit 12 having an optical image sensing device and others and a control unit 14 for controlling the observation unit. The observation unit 12 and the control unit 14 are connected through the storage area network 40 to a storage device 30 outside the inspection apparatus, a storage device 31 inside the inspection apparatus, and a plurality of inspection processing apparatus 60. The storage area network 40 has a plurality of fabrics 42, to each of which the units and apparatus are connected via fiber channels 41. The fabrics 42 are interconnected also by a fiber channel 43. In this case, when the connections 43 between a plurality of fabrics are replaced with WAN such as ATM, the inspection apparatus may be installed in a clean room at the manufacturing site and the inspection processing apparatus in a remote office.

Detailed Description Text (33):
FIG. 24 and FIG. 25 are block diagrams showing semiconductor manufacturing apparatus as embodiments of this invention. FIG. 24 is a block diagram showing an overall configuration of the system. As shown in the figure, the manufacturing apparatus 20 comprises an exposure unit 22 having an optical exposure means or charged particle exposure means, and a control unit 24 for controlling the exposure unit. The exposure unit 22 and the control unit 24 are connected through the storage area network 40 to a storage device 30 outside the manufacturing apparatus,

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a storage device 32 inside the manufacturing apparatus, and an apparatus 60 other than the manufacturing apparatus 20. This configuration allows the storage devices to be shared among the units and apparatus.

Detailed Description Text (34):
FIG. 25 is a block diagram showing a semiconductor manufacturing apparatus with its control unit connected to the storage area network. As shown in the figure, the manufacturing apparatus 20 comprises an exposure unit 22 having an optical exposure means or charged particle exposure means, and a control unit 24 for controlling the exposure unit. The control unit 24 is connected through the storage area network 40 to a storage device 30 outside the manufacturing apparatus, a storage device 32 inside the manufacturing apparatus, and an apparatus 60 other than the manufacturing apparatus 20. This configuration allows the control unit to access all the storage devices inside or outside the manufacturing apparatus.

Detailed Description Text (35):
FIG. 26 is a block diagram showing a semiconductor inspection apparatus with a plurality of design information processing apparatus 60 connected to the storage area network. As shown in the figure, the manufacturing apparatus 20 comprises an exposure unit 22 having an optical exposure means or charged particle exposure means, and a control unit 24 for controlling the exposure unit. The exposure unit 22 and the control unit 24 are connected through the storage area network 40 to a storage device 30 outside the manufacturing apparatus, a storage device 32 inside the manufacturing apparatus, and a plurality of design information processing apparatus 60. With this configuration, because a plurality of design information processing apparatus 60 can store in the storage device 30 design information processed for use in the manufacturing apparatus 20, the parallel manufacture processing can easily be realized, thus improving the overall performance of the system. A design information processing apparatus 60 can be added to or removed from the storage area network while the system is in operation. Hence, when new design information processing is requested, an additional design information processing apparatus can be added without halting the system, thus improving the system extension capability.

Detailed Description Text (36):
FIG. 27 is a block diagram showing an example case where a plurality of semiconductor manufacturing apparatus are connected to the storage area network. As shown in the figure, a plurality of manufacturing apparatus 20 can access design information stored in the storage device 30 via the storage area network. Therefore, for the same design information a plurality of manufacturing apparatus can parallelly execute the manufacturing process at the same time, improving the overall performance of the system.

Detailed Description Text (37):
FIG. 28 is a block diagram showing a semiconductor manufacturing apparatus when a fiber channel is adopted for the storage area network and a dedicated hardware is used for the control unit. As shown in the figure, the manufacturing apparatus 20 comprises an exposure unit 22 having an optical exposure means or charged particle exposure means, and a control unit 24 for controlling the exposure unit. The exposure unit 22 and the control unit 24 are connected through the storage area network 40 to a storage device 30 outside the manufacturing apparatus, a storage device 32 inside the manufacturing apparatus, and a plurality of design information processing apparatus 60. The storage area network 40 has a plurality of fabrics 42, to which various units and apparatus are connected by fiber channels 41. The fabrics 42 are interconnected also by the fiber channel 43. The control unit 24 comprises a BM (buffer memory) 25 for temporarily storing design information, a recovery unit 26 for processing the design information for use in the control unit 24, a dividing unit 27 for dividing the data processed by the recovery unit 26 into minimum geometric units such as rectangles, a proximity correction unit 28 for executing a proximity effect correction on the minimum geometric units divided by

the dividing unit, and a shot unit 29 for converting the data into shot information conforming to the exposure unit 22.

Detailed Description Text (40):
First, the shot information stored in the storage device 30 or storage device 32 (S900) is read out and, based on the shot information read out, the writing pattern is recovered (S910). The shot information is a set of minimum geometric units such as rectangles and the writing pattern can be recovered by performing interpolation between the unit geometries. Next, design information is read out (S920). The formats of the writing pattern and the design information are often CAD data or vector data and, when the format of the design information differs from that of the writing pattern, it needs to be converted. Then, the writing pattern and the design information are compared (S930). When they agree, it is decided that the processing has been executed accurately (S940). When they disagree, it is decided that the processing was not accurate (S950). When they disagree, the location of disagreement is stored in the storage device 30 so that the stored information may be used as control data for a micro-fabrication machine using FIB (focused ion beam) which is connected to the storage area network 40.

Detailed Description Text (45):
(1) A semiconductor production system comprising: a semiconductor manufacturing apparatus having an exposure unit, a control unit for controlling the exposure unit and a storage device; a semiconductor inspection apparatus having an observation unit, a control unit for controlling the observation unit and a storage device; a storage device commonly used by the semiconductor manufacturing apparatus and the semiconductor inspection apparatus; and a storage area network for interconnecting the semiconductor manufacturing apparatus, the semiconductor inspection apparatus and the commonly used storage device.

Detailed Description Text (46):
(2) The semiconductor production system according to item (1), wherein the storage area network has a plurality of fabrics for switching fiber channels.

Detailed Description Text (54):
(10) The semiconductor production system according to any one of items (1) to (9), wherein the storage area network has a computer to generate the inspection position to reduce a burden on the semiconductor inspection apparatus or the semiconductor manufacturing apparatus.

Detailed Description Text (56):
(12) The semiconductor production system according to any one of items (1) to (11), wherein the storage area network stores a requirement specification of a semiconductor device to be manufactured, information representing the inspection result, and link information linking these information with an ID of a storage device in which these information is stored.

Detailed Description Text (57):
(13) The semiconductor production system according to any one of items (1) to (12), wherein the storage area network has a display device for calculating and displaying a processing time or processing position of the semiconductor manufacturing apparatus.

Detailed Description Text (58):
(14) The semiconductor production system according to any one of items (1) to (13), wherein the storage area network has an estimating means for estimating a performance of a semiconductor device from the inspection result of the semiconductor inspection apparatus.

Other Reference Publication (1):
Phillips, B; "Have Storage Area Networks Come Of Age ?"; Computer; Vol. 31, Issue

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7; Jul. 1998; pp 10-12

CLAIMS:

1. A semiconductor production system comprising: a semiconductor manufacturing apparatus having an exposure unit, a control unit for controlling the exposure unit and a storage device; a semiconductor inspection apparatus having an observation unit, a control unit for controlling the observation unit and a storage device; a storage device commonly used by the semiconductor manufacturing apparatus and the semiconductor inspection apparatus; and a storage area network for interconnecting the semiconductor manufacturing apparatus, the semiconductor inspection apparatus and the commonly used storage device.

2. The semiconductor production system according to claim 1, wherein the storage area network has a plurality of fabrics for switching fiber channels.

11. The semiconductor production system according to claim 1, wherein the storage area network has a computer to generate the inspection position to reduce a burden on the semiconductor inspection apparatus or the semiconductor manufacturing apparatus.

12. The semiconductor production system according to claim 1, wherein the storage area network stores a requirement specification of a semiconductor device to be manufactured, information representing the inspection result, and link information linking these information with an ID of a storage device in which these information is stored.

13. The semiconductor production system according to claim 1, wherein the storage area network has a display device for calculating and displaying a processing time or processing position of the semiconductor manufacturing apparatus.

14. The semiconductor production system according to claim 1, wherein the storage area network has an estimating means for estimating a performance of a semiconductor device from the inspection result of the semiconductor inspection apparatus.

☐ 4. Document ID: US 6389432 B1

L3: Entry 4 of 6 File: USPT May 14, 2002

DOCUMENT-IDENTIFIER: US 6389432 B1
**** See image for Certificate of Correction ****
TITLE: Intelligent virtual volume access

Brief Summary Text (4):
The storage and management of data have driven the development of new storage architectures--Network Attached Storage (NAS) and Storage Area Network (SAN)--to meet growing storage demand.

Brief Summary Text (11):
Implementations of the invention may include one or more of the following. The searching step can be performed by an external manager. The attributes of a device can be statically configured in a server. The attributes of a device can be

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statically configured in a switch. Each data storage device can broadcast its attributes to a manager. The manager can store the attributes in the table, or can statically configures the attributes of a device. Each data storage device can broadcast value-added services associated with the data storage device to the manager. The manager can communicate using a Fibre Channel protocol. Further, each manager can manage one or more virtual volumes on each data storage device. The requester and the data storage devices can communicate using a network protocol. The network protocol can be an Internet Protocol (IP), an Asynchronous Transfer Mode (ATM) protocol, or an in-band control protocol which may be a Small Computer System Interface (SCSI) protocol. A server can manage the data storage device and can communicate using the Fibre Channel protocol. Alternatively, a switch can manages the data storage devices. The switch can communicate using the Fibre Channel protocol. The manager can communicate with other managers over a network. In this case, the searching step includes querying one or more tables in one or more remote storage area networks over the network; returning a remote identification associated with a portion of the selected data storage devices to the requester; and accessing the portion of the selected data storage device using the remote identification. The data storage devices may be a disk drive or a tape drive. The identification can a logical unit number. The requester can be a server or another manager. The method also includes performing manager operations to allocate space. The manager operations include one operation selected from a group of commands to initialize, attach, detach, connect, bind, write, read, move, signal, query, convert, control, and callback data in a storage partition.

Brief Summary Text (12):
In another aspect, a system for responding to a request for storage space includes one or more storage area networks (SANs); one or more data storage devices coupled to the one or more SANs; a requester coupled to one of the SANS; and a manager for supervising requests for storage space. The manager being operable to receive a request for storage space from a requester, the request specifying one or more criteria associated with the requested storage space; search a data structure containing attributes associated with the data storage devices; select one of the data storage devices whose attributes best match the one or more criteria; return an identification associated with a portion of the selected data storage devices to the requester; and create a communication path between the requester and the selected data storage device.

Detailed Description Text (21):
FC-4, the highest level in the FC structure defines the application interfaces that can execute over Fibre Channel. It specifies the mapping rules of upper layer protocols using the FC levels below. Fibre Channel is equally adept at transporting both network and channel information and allows both protocol types to be concurrently transported over the same physical interface using a channel function 242 and a network function 244. The following network and channel protocols may be supported: Small Computer System Interface (SCSI); Intelligent Peripheral Interface (IPI); High Performance Parallel Interface (HIPPI) Framing Protocol; Internet Protocol (IP); ATM Adaptation Layer for computer data (AAL5); Link Encapsulation (FC-LE); Single Byte Command Code Set Mapping (SBCCS); and IEEE 802.2

Other Reference Publication (2):
P. Massiglia, "Fibre Channel, Storage Area Networks, and Disk Array Systems," Adaptec, Inc. Apr. 13, 1998, 22 pgs.

CLAIMS:

1. A method for managing storage space in one or more data storage devices coupled to a storage area networks (SAN), the method comprising:

receiving a request for storage space from a requester coupled to the SAN, the request specifying one or more criteria associated with the requested storage

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space;

selecting one of the data storage devices according to volume characteristics of the devices, where the selected device is a device having volume characteristics that best match the one or more criteria specified in the request;

returning an identification associated with the selected data storage device to the requester; and

creating a communication path between the requester and the selected data storage device.

27. A system comprising:

a storage area networks (SAN);

one or more data storage devices coupled to the SAN;

a requester coupled to the SAN; and

a manager for supervising requests for storage space, the manager being operable to:

receive a request for storage space from the requester, the request specifying one or more criteria associated with the requested storage space;

select one of the data storage devices according to volume characteristics of the devices, where the selected device is a device having volume characteristics that best match the one or more criteria specified in the request;

return an identification associated with the selected data storage devices to the requester; and

create a communication path between the requester and the selected data storage device.

☐ 5. Document ID: US 6199112 B1

L3: Entry 5 of 6 File: USPT Mar 6, 2001

DOCUMENT-IDENTIFIER: US 6199112 B1
TITLE: System and method for resolving fibre channel device addresses on a network using the device's fully qualified domain name

Abstract Text (1):
A method and system for discovering the location of a storage router, and therefore the attached storage devices, in a fibre channel network using the storage router's fully qualified domain name to ultimately determine the storage router's arbitrated loop physical address (AL_PA). An Internet protocol domain name query containing the fully qualified domain name is sent from a host computer over the storage area network to a domain name server to determine an Internet Protocol address for the

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storage router. The domain name server replies with the storage router Internet Protocol address. The host computer then sends an address resolution protocol request containing the Internet protocol address over the storage area network to determine a node name for the storage router. The storage router replies with its node name. The host computer then sends an FCP request containing the storage router's node name over the storage area network to determine an arbitrated loop physical address of the storage router. The storage router replies with its arbitrated loop physical address. The host computer can use a variety of standard inquiries discover storage devices attached to the storage router. The communication can then continue in fibre channel protocol between the storage and the host computer.

Brief Summary Text (7):
With the relatively recent development of storage area networks incorporating storage routers, locating both the router and storage devices associated with that router presents some challenges. In a storage area network, the I/O bus is geographically distributed throughout the storage area network. Storage routers, to which the storage devices can be locally attached, can be moved from one physical location to another depending on the needs at various times. This change in physical location of storage routers (and thus change in physical addresses) presents problems in locating both the storage router and storage devices in the storage area network.

Brief Summary Text (10):
More specifically, the present invention provides a system for determining a fibre channel device address on a storage network using the device's fully qualified domain name. To accomplish the fibre channel device discovery, a domain name query is sent from a host computer to a domain name server that includes the fully qualified domain name of the device (such as a storage router) in order to obtain the Internet Protocol address for the storage router. After locating the Internet Protocol address for the storage router based on the fully qualified domain name, the domain name server will send the storage router's Internet Protocol address to the host computer. The host computer then sends an address resolution protocol request containing the storage router's Internet protocol address over the storage area network to determine a node name for the storage router. The storage router gets the request and responds with an address resolution protocol reply containing its node name to the host computer. The host computer sends a fibre channel address resolution protocol request containing the storage router node name to the storage router to determine the router's physical address. The storage router responds with a fibre channel address resolution protocol reply containing the storage router's physical address to the host computer.

Brief Summary Text (13):
The present invention provides another technical advantage by facilitating the discovery of a fibre channel storage device in a storage area network that is compatible with an application using the fully qualified domain name of the storage router to which that storage device is locally attached.

Brief Summary Text (14):
The present invention provides another technical advantage by allowing a server to locate a particular fibre channel device in a storage area network even if the storage router to which the device is attached has changed physical location.

Drawing Description Text (3):
FIG. 1 shows an exemplary storage area network incorporating an embodiment of the present invention; and

Detailed Description Text (3):
Fibre channel can support both Internet protocol (IP) or small computer system interface (SCSI)/fibre channel protocol (FCP). The present invention uses a storage

router's fully qualified domain name (IP) to discover the address of the storage router in order to locate and use a storage device attached to the storage router within a storage area network using fibre channel.

Detailed Description Text (4):
In a fibre channel storage area network, each storage router has an arbitrated loop physical address (AL_PA) which is an FCP address. However, the AL_PA can change each time a device is inserted into the arbitrated loop or a loop initialization occurs. Thus, the AL_PA is a dynamic address. The AL_PA of a storage router must be discovered in order to communicate from the server to that storage router. In addition, every fibre channel device, such as a storage router, has an organizationally unique fully qualified domain name and IP address associated with it. Unlike the AL_PA, the fully qualified domain name and IP addresses are static addresses that do not change. Thus, a particular storage router will always have the same fully qualified domain name and IP address, but the AL_PA associated with the storage router can change. However, once the AL_PA of a storage router is known, a client application on a host computer can locate any storage devices associated with that storage router.

Detailed Description Text (5):
FIG. 1 shows an exemplary fibre channel storage area network 10 containing an arbitrated loop 12 connecting a host computer 14, a first storage router 16 and a second storage router 18. A domain name service server 20 (or dns server) is fibre channel attached to the storage area network 10. Storage devices 30 are directly attached to storage router 16, while storage device 72 is directly attached to storage router 18. As shown in FIG. 1, storage devices 30 are SCSI hard disk devices while storage device 72 is a SCSI tape drive to provide the storage capability of the storage area network.

Detailed Description Text (6):
Storage routers 16 and 18 include a processor for executing software programs and memory for storing software programs and data files. The storage router used in conjunction with the present invention must support at least two protocols on its Fibre Channel interface connected to the storage area network: Fibre Channel Protocol (which is SCSI encapsulated over fibre channel), which can be used by the host computer to discover and communicate with SCSI storage devices attached to the storage router, and Address Resolution Protocol (ARP)/Fibre Channel Address Resolution Protocol (FARP), which can be used by the host to discover the location, or fibre channel address, of the storage router.

Detailed Description Text (7):
The dns server 20 contains a record resource look-up table 24 of fully qualified domain names correlating to IP addresses for devices on the network 10. The host computer 14 can contain a device name file 26 of fully qualified domain names for storage routers on the storage area network 10. Further, a client application 28 resident on or accessible by the host computer 14 can optionally include the fully qualified domain name for each storage device locally attached to each storage router it wishes to access. For example, with reference to FIG. 1, storage router 16 could have a fully qualified domain name of "clarion.hp.com" and storage router 18 could have a fully qualified domain name of "redwood1.crossroads.com". Tape drive 72 is connected to storage router 18, or "redwood1.crossroads.com", and the device name file 26 would identify tape drive 72 with storage router 18. Likewise, hard disk storage devices 30 would be associated with storage router 16, or "clarion.hp.com" on the host name file 26.

Detailed Description Text (8):
The present invention will be described using the exemplary arbitrated loop fibre channel topology as shown in FIG. 1. It should be understood that the present invention is equally applicable to other fibre channel topologies. It should further be understood that additional arbitrated loops having additional storage

router(s) and additional storage device(s) could be part of the storage area network 10. It should be further understood that the present invention can work to discover either native SCSI or fibre channel storage devices behind a storage router.

Detailed Description Text (9):
In order to communicate with a Fibre Channel device, such as a storage router, the host computer must be FCP compatible and needs to discover the AL_PA for the device. The host computer 14 communicates with SCSI storage devices 30 and 72 through the storage routers 16 and 18, respectively. The storage device's AL_PA can be determined if the AL_PA of the storage router is known. A storage router is addressable on its Fibre Channel interface by its IP address that is saved in the storage router memory. These IP addresses are generated using standard Internet IP address acquisition techniques, currently through InterNic. This IP address for the storage router is saved as a resource record in resource record look-up table 24 on the dns server 20 connected to the storage area network 10.

Detailed Description Text (10):
Host computer 14 in FIG. 1 may need access to any of the storage devices 30 and 72 in the storage area network 10. However, the host computer 14 must obtain or discover the location of that particular storage device. With the present invention, the host computer 14 utilizes both IP and FCP to first discover the location of the storage router associated with the storage device desired based on that storage router's fully qualified domain name. The present invention does this by acquiring and translating from the storage router IP address to the storage router's node name and from node name to AL_PA. The host computer 14 can then perform a standard inquiry to determine the storage devices connected to that router to allow the host computer to communicate with a compatible storage device.

Detailed Description Text (11):
With reference to FIG. 2, a description of how the host computer 14 can discover a storage device location based on the storage router's fully qualified domain name is provided. At step 1, a dns query software program 32 resident on the host computer 14 sends a query to the dns server 20 requesting a response as to what storage router has a particular fully qualified domain name. For example, if storage router 18 has the fully qualified domain name, "redwood1.crossroads.com", then the dns request for fully qualified domain name "redwood1.crossroads.com" will be a request for the IP address of storage router 18. As discussed above, the fully qualified domain name is a static address, while the AL_PA is a dynamic name. While the client application knows the fully qualified domain name of the storage router in the storage area network, the current AL_PA for that storage router will not necessarily be known. The dns query would be in traditional Internet protocol that would be sent out over the fibre channel host bus adapter. The fibre channel host bus adapter at the dns server 20 can receive and process both IP and ARP/FARP messages.

Detailed Description Text (12):
The dns server 20 has a look-up table 24 of resource records that correlates fully qualified domain names to IP addresses for storage routers on the arbitrated loop 12. At step 2, the dns server 20 receives the dns query packet and replies to the host computer 14 with the IP address for storage router 18 using a dns reply software program 34 resident in memory on the dns server 20. At step 3, the host computer 14 receives the storage router's IP address and sends a broadcast address resolution protocol (ARP) request over the storage area network 10 that includes the IP address for storage router 18. The ARP request is sent by an ARP request software program 36 resident on or accessible by the host computer 14. This ARP request is a request to find the FC node name that matches the IP address sent in the request. In other words, this ARP request is designed to swap the storage router's IP address for the storage router's FC node name. Each fibre channel device has an organizationally unique FC node name. This unique FC node name (or

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world wide name) is currently defined to begin with an OUI (or organizationally unique identifier) and has an eight byte total length. It should be understood that the present invention can still accomplish its intended results based on any structure of unique FC node name.

Detailed Description Text (13):
At step 4, storage routers 16 and 18 in the storage area network 10 receive the ARP request with the IP address for storage router 18, and only storage router 18 (because it was the router matching that IP address) sends an ARP reply containing its FC node name. Only the particular storage router having the IP address in the ARP request will reply to the ARP request. The ARP reply can be sent using an ARP reply software program 38 resident on each storage router. The host computer 14 receives the ARP reply including the node name of storage router 18 and can cache the node name. The host computer 14 has now gone from the fully qualified domain name of the router to the router's FC node name.

Detailed Description Text (14):
At step 5, the host computer 14 sends a broadcast fibre channel address resolution protocol (FARP) request that includes the node name for storage router 18 to the storage area network 10 to request the AL_PA (or Port_ID) of storage router 18. This FARP request can be sent using a FARP request software program 40 resident on or accessible by the host computer 14. At step 6, storage router 18 sends a FARP reply using a FARP reply software program 42, the FARP reply including the storage router's 18 AL_PA (or Port ID) to the host 14. The host 14 has now discovered the AL_PA for storage router 18 from the router's fully qualified domain name. In this manner, the AL_PA for storage router 18 is discovered.

Detailed Description Text (15):
In an optional step 7, the host computer 14 can perform a number of known discovery methods (as defined in various SCSI specifications) to determine the physical locations of storage device 72 directly attached to the storage router 18. For example, the host computer 14 can issue inquiries to every AL_PA by walking through all possible luns (FCP_LUN) at each AL_PA, or a REPORT LUNS to discover storage device 72 attached to storage router 18 and determine whether the application is compatible with storage device 72. The AL_PA for storage router 16, and therefore, storage devices 30, can be discovered similarly. After the discovery of a compatible storage device 30 or 72 has occurred, the communication between the storage device and the application at the host computer can occur using FCP, rather than IP or some other protocol. If none of the storage devices locally attached to the storage router 18 are compatible, the host computer 14 could execute steps 1-7 again with storage router 16 and storage devices 30, or any other storage router on the storage area network 10.

CLAIMS:

1. A method for resolving a fibre channel device address on a network from a fully qualified domain name of a device, comprising:

sending a domain name query containing the fully qualified domain name from a host computer over the network to a domain name server to determine an Internet Protocol address for the device;

locating at the domain name server the Internet Protocol address for the device based on the fully qualified domain name;

sending the device Internet Protocol address to the host computer;

sending an address resolution protocol request containing the Internet protocol address from the host computer over the storage area network to determine a node name for the device;

sending an address resolution protocol reply containing the device node name to the host computer;

sending a fibre channel address resolution protocol request containing the device node name from the host computer to the device to determine a physical address of the device; and

sending a fibre channel address resolution protocol reply containing the device physical address to the host computer.

2. The method of claim 1, wherein the device is a storage router capable of supporting both fibre channel protocol and address resolution protocol, and further wherein the network is a storage area network.

13. The method of claim 1, wherein the network is a storage area network.

15. A method for resolving a fibre channel device address on a storage area network from a fully qualified domain name of a storage router capable of supporting both fibre channel protocol and address resolution protocol, comprising:

sending an Internet protocol domain name query containing the fully qualified domain name from a host computer over the storage area network to a domain name server to determine an Internet Protocol address for the storage router;

locating at the domain name server the Internet Protocol address for the storage router based on the fully qualified domain name;

sending an Internet protocol reply containing storage router Internet Protocol address from the domain name server to the host computer;

sending an address resolution protocol request containing the Internet protocol address from the host computer over the storage area network to determine a node name for the storage router;

sending an address resolution protocol reply containing the storage router node name to the host computer;

sending a fibre channel address resolution protocol request containing the device node name from the host computer to the storage router to determine an arbitrated loop physical address of the storage router; and

sending a fibre channel address resolution protocol reply containing the storage router arbitrated loop physical address to the host computer.

17. A system for resolving a fibre channel device address from a fully qualified domain name of a device in a storage area network, comprising:

a storage router, comprising a fibre channel interface that supports both fibre channel protocol and address resolution protocol;

a host computer capable of supporting Internet protocol and fibre channel protocol, the host computer comprising:

a client application; and

a data file containing a list of fully qualified domain names for each storage router in the storage area network; and

a domain name server comprising a resource record look-up table, wherein the

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resource record look-up table contains the Internet protocol address and fully qualified domain name of the storage router configured such that the Internet protocol address can be discovered from the fully qualified domain name, and wherein;

the client application is operable to access the data file and send a domain name query containing the fully qualified domain name for the storage router over the storage area network to the domain name server to determine the Internet Protocol address for the storage router;

the domain name server discovers the Internet Protocol address for the storage router based on the fully qualified domain name and sends the storage router Internet Protocol address to the client application;

the client application sends an address resolution protocol request containing the Internet protocol address over the storage area network to determine a node name for the storage router;

the storage router sends an address resolution protocol reply containing the storage router node name to the client application;

the client application sends a fibre channel address resolution protocol request containing the storage router node name to the storage router to determine a physical address of the storage router; and

the storage router sends a fibre channel address resolution protocol reply containing the device physical address to the client application.

22. A system for resolving a storage router physical address from a fully qualified domain name of a storage router in a storage area network, comprising:

a host computer capable of supporting Internet protocol and fibre channel protocol, comprising:

a host processor;

a host memory;

a dns query software program resident on the host memory;

an ARP request software program residing on the host memory; and

a FARP request software program residing on the host memory;

a domain name server capable of supporting Internet protocol and fibre channel protocol, comprising:

a domain name server processor;

a domain name server memory;

a resource record look-up table containing the Internet protocol address and fully qualified domain name of the storage router, such resource record look-up table configured in a way that the Internet protocol address can be discovered from the fully qualified domain name; and

a dns reply software program resident on the domain name server memory; and

a storage router, comprising:

a fibre channel interface that is addressable by the Internet Protocol address to allow support of both fibre channel protocol and address resolution protocol;

a storage router processor;

a storage router memory

an ARP reply software program resident on the storage router memory; and

a FARP reply software program resident on the storage router memory, and wherein:

the dns query software program is operable to direct the host processor to send a domain name query containing the fully qualified domain name of the storage router over the storage area network to the domain name server;

the dns reply software program is operable to direct the domain name server to access the resource record look-up table and discover the Internet Protocol address for the storage router based on the fully qualified domain name in the domain name query and to send a dns reply to the host computer that contains the storage router Internet Protocol address;

the ARP request software program operable to direct the host processor to send an address resolution protocol request containing the storage router Internet protocol address over the storage area network to determine a node name for the storage router;

the ARP reply software program operable to direct the storage router processor to send an address resolution protocol reply containing the storage router node name to the host computer;

the FARP request software program operable to direct the host processor to send a fibre channel address resolution protocol request containing the storage router node name to the storage router to determine a physical address of the storage router; and

the FARP reply software program operable to direct the storage router processor to send a fibre channel address resolution protocol reply containing the storage router physical address to the client application.

23. The system of claim 22, further comprising:

a data file containing a list of fully qualified domain names for each storage router in the storage area network; and

a client application resident on the host memory, the client application operable to direct the host processor to access the data file, obtain the fully qualified domain name of the storage router, and send the domain name query to the domain name server.

☐ 6. Document ID: US 6151331 A

L3: Entry 6 of 6 File: USPT Nov 21, 2000

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DOCUMENT-IDENTIFIER: US 6151331 A
TITLE: System and method for providing a proxy FARP for legacy storage devices

Brief Summary Text (5):
Fibre channel topology can be selected depending on system performance requirements or packaging options. On fibre channel topologies commonly used in storage area networks is an arbitrated loop. In an arbitrated loop fibre channel topologies, storage devices, such as hard disk storage devices and tape devices, can be used to store data that can be retrieved by a software application. In order to save or retrieve data from any particular storage device, the storage device must first be located.

Brief Summary Text (7):
Without some mechanism to discover these legacy SCSI devices in a storage area network, FARP inquiries from a host computer will be ignored by these SCSI storage devices, the host will not get a reply and will respond as if the storage device does not exist on the storage area network.

Brief Summary Text (12):
The present invention provides an important technical advantage by allowing the use and discovery of legacy SCSI devices on a storage area network using FARP protocol.

Brief Summary Text (13):
The present invention provides another technical advantage by allowing users to continue to use their existing storage devices (many of which are SCSI) in storage area networks utilizing FARP address discovery.

Drawing Description Text (3):
FIG. 1 shows an exemplary storage area network incorporating an embodiment of the present invention;

Drawing Description Text (4):
FIG. 2 is a flow diagram illustrating one embodiment of the method of discovering storage devices on a storage area network that are not FARP compatible;

Drawing Description Text (5):
FIG. 3 is a flow diagram illustrating an embodiment of the present invention for replying to FARP discovery requests for storage devices on a storage area network that are not FARP compatible; and

Detailed Description Text (3):
Fibre channel can support both fibre channel address resolution protocol (FARP) and small computer system interface (SCSI) protocol. Thus, fibre channel storage area networks can have both FARP compatible storage devices and legacy SCSI storage devices that are not FARP compatible. The present invention allows the discovery of storage devices that do not support FARP that are attached over a fibre channel network to a storage router by using the storage router as a proxy to answer FARP requests to those storage devices.

Detailed Description Text (4):
FIG. 1 shows an exemplary fibre channel storage area network 10 having a host computer 14 connected through a fibre channel switch 12 to an arbitrated loop 16. It should be understood that the present invention is applicable to other fibre channel topologies. The host computer 14 is operable to send FARP broadcasts and is compatible with SCSI devices and can include client software application 34. The arbitrated loop 16 includes a storage router 18 and a FARP compatible storage device 20 and a SCSI storage device 30 that is not FARP compatible. It should be

understood that additional arbitrated loops (or other topologies) having additional storage router(s) and additional storage device(s) could be part of the storage area network 10.

Detailed Description Text (6):
Storage router 18 used in conjunction with the present invention must support Fibre Channel Protocol (which is SCSI encapsulated over fibre channel), which can be used by the host computer to discover and communicate with SCSI storage devices attached to the storage router, and Address Resolution Protocol (ARP), which can be used by the host to discover the location, or fibre channel address, of the storage device. Storage router 18 includes a processor and a storage medium or memory. The storage router 18 for use with the present invention also includes a node name discovery software program 24 resident on the storage medium that, when executed, will travel the arbitrated loop 16 and record the node name and arabitrated loop port address AL.sub.-- PA for storage devices 20 and 30 in a look-up table 22. The storage router 18 also includes a FARP request software program 26 resident on the storage medium that, when executed, will send a FARP request from the storage router 18 to determine which storage devices attached to the storage router 18 are FARP compatible and record that information in the look-up table 22. Storage router 18 also includes a proxy FARP software program 28 resident on the storage medium that, when executed, will act as a proxy and respond to FARP requests for storage devices that are not FARP capable. It should be understood that the node name discovery software program 24, the FARP request software program 26, and the proxy FARP software program 28 could be included in a single software program.

Detailed Description Text (7):
FIG. 2 shows a flow diagram according to the present invention for determining all of the storage devices that are not FARP compatible connected to each storage router and holding that information in a look-up table. For example, the diagram of FIG. 2 illustrates one method for determining that SCSI storage device 30 and storage device 20 of FIG. 1 are attached to storage router 18 in storage area network 10 and storing that information at storage router 18.

Detailed Description Text (13):
The present invention can also be used in conjunction with another discovery technique to discover storage devices locally attached to the storage router's SCSI interface, such as tape drive 72. Thus providing the capability to discover any legacy SCSI device on the storage area network, whether the storage device is locally attached to the router at a SCSI interface or is on an arbitrated loop and attached to the router through an FC interface.

Detailed Description Text (14):
With reference to FIGS. 1 and 4, a description of how the host computer 14 can discover a legacy SCSI storage device that is locally attached to a storage router through a SCSI interface is provided. At step 301, a dns query software program 32 resident on the host computer 14 sends a query to the dns server 50 requesting a response as to what storage router has a particular fully qualified domain name. For example, if storage router 18 has the fully qualified domain name, "redwood1.crossroads.com", then the dns request for fully qualified domain name "redwood1.crossroads.com" will be a request for the IP address of storage router 18. The fully qualified domain name is a static address, while the AL.sub.-- PA is a dynamic name. While client application 14 knows the fully qualified domain name of the storage router in the storage area network, the current AL.sub.-- PA for that storage router will not necessarily be known. The dns query would be in traditional Internet protocol that would be sent out over the fibre channel host bus adapter. The fibre channel host bus adapter at the dns server 50 can receive and process both IP and SCSI messages.

Detailed Description Text (15):
The dns server 50 has a look-up table 52 of resource records that correlates fully

qualified domain names to IP addresses for storage routers on the arbitrated loop 16. At step 302, the dns server 50 receives the dns query packet and replies to the host computer 14 with the IP address for storage router 18 using a dns reply software program 54 resident in memory on the dns server 50. At step 303, the host computer 14 receives the storage router's IP address and sends a broadcast address resolution protocol (ARP) request over the storage area network 10 that includes the IP address for storage router 18. The ARP request is sent by an ARP request software program 36 resident on or accessible by the host computer 14. This ARP request is a request to find the node name that contains the storage router IP address sent in the request. Each fibre channel device has an organizationally unique node name which is currently defined to begin with an OUI (or organizationally unique identifier) and has an eight byte total length. It should be understood that the present invention can still accomplish its intended results based on any structure of unique FC World Wide Node Name.

Detailed Description Text (17):
At step 305, the host computer 14 sends a broadcast fibre channel address resolution protocol (FARP) request that includes the node name for storage router 18 to the storage area network 10 to request the AL.sub.-- PA (or Port.sub.-- ID) of storage router 18. This FARP request can be sent using a node name FARP request software program 40 resident on or accessible by the host computer 14. In this manner, the AL.sub.-- PA for storage router 18 is discovered. At step 306, storage router 18 sends a node name FARP reply using a node name FARP reply software program 42, the FARP reply including the storage router's 18 AL.sub.-- PA (or Port ID) to the host 14. The host 14 has now discovered the AL.sub.-- PA for storage router 18 from the router's fully qualified domain name.

Detailed Description Text (19):
Assuming storage device 72 is compatible with the client application 14, the communication between the storage device and the client application at the host computer can occur using FCP, rather than IP or some other protocol. If none of the storage devices locally attached to the storage router 18 are compatible, the host computer 14 could execute steps 1-7 again any other storage routers on the storage area network 10.

CLAIMS:

12. The method of claim 11, wherein the storage device is connected to the storage router via a local SCSI interface, and wherein the discovery by the storage router further comprises:

sending an Internet protocol domain name query containing a fully qualified domain name from a second application resident on the host computer over a storage area network to a domain name server to determine an Internet Protocol address for the storage router;

locating at the domain name server the Internet Protocol address for the storage router based on the fully qualified domain name;

sending an Internet protocol reply containing storage router Internet Protocol address from the domain name server to the application;

sending an address resolution protocol request containing the Internet protocol address from the application over the storage area network to determine a node name for the storage router;

sending an address resolution protocol reply containing the storage router node name to the application;

sending a fibre channel address resolution protocol request containing the device

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node name from the application to the storage router to determine an arbitrated loop physical address of the storage router;

sending a fibre channel address resolution protocol reply containing the storage router arbitrated loop physical address to the application; and

sending a storage device discovery command from the application to the storage router to discover a storage device attached to the storage router.

17. The system of claim 13, wherein the storage device is connected to the storage router via a local SCSI interface, and wherein the system further comprises:

a host computer capable of supporting Internet protocol and fibre channel protocol, comprising:

a host processor;

a host memory;

a domain name system (dns) query software program resident on the host memory;

an address resolution protocol (ARP) request software program residing on the host memory;

a node name FARP request software program residing on the host memory; and

a storage device discovery software program resident on the host memory;

a domain name server capable of supporting Internet protocol and fibre channel protocol, comprising:

a domain name server processor;

a domain name server memory;

a resource record look-up table containing Internet protocol address and fully qualified domain name of the storage router, such resource record look-up table configured in a way that the Internet protocol address can be discovered from the fully qualified domain name; and

a dns reply software program resident on the domain name server memory; and

a storage router, comprising:

a fibre channel interface that is addressable by the Internet Protocol address to allow support of both fibre channel protocol and address resolution protocol;

a storage router processor;

a storage router memory an ARP reply software program resident on the storage router memory; and

a node name FARP reply software program resident on the storage router memory, and wherein:

the dns query software program is operable to direct the host processor to send a domain name query containing the fully qualified domain name of the storage router over the storage area network to the domain name server;

the dns reply software program is operable to direct the domain name server to, in

response to the dns query, access the resource record look-up table and discover the Internet Protocol address for the storage router based on the fully qualified domain name in the domain name query and to send a dns reply to the host computer that contains the storage router Internet Protocol address;

the ARP request software program operable to direct the host processor to, in response to the dns reply, send an address resolution protocol request containing the storage router Internet protocol address over the storage area network to determine a node name for the storage router;

the ARP reply software program operable to direct the storage router processor to, in response to the address resolution protocol request, send an address resolution protocol reply containing the storage router node name to the host computer;

the node name FARP request software program operable to direct the host processor to send a fibre channel address resolution protocol request containing the storage router node name to the storage router to determine a physical address of the storage router;

the node name FARP reply software program operable to direct the storage router processor to send a fibre channel address resolution protocol reply containing the storage router physical address to the client application; and

the storage device inquiry software program sends a storage device inquiry to the storage router to discover the storage device attached to the storage router.

18. The system of claim 17, further comprising:

a data file containing a list of fully qualified domain names for each storage router in the storage area network; and

a client application resident on the host memory, the client application operable to direct the host processor to access the data file, obtain the fully qualified domain name of the storage router, and send the domain name query to the domain name server.

Term	Documents
STORAGE	663356
STORAGES	2912
AREA	1332591
AREAS	615009
NETWORK	272930
NETWORKS	106836
(2 AND ((STORAGE ADJ1 AREA) ADJ1 NETWORK)).USPT.	6
(L2 AND (STORAGE ADJ1 AREA ADJ1 NETWORK)).USPT.	6

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